

RADIOGRAPHIC ANALYSIS OF  
AGRICULTURAL AND FOREST TREE SEEDS

Contribution No. 31  
to the Handbook on Seed Testing

prepared for

The Seed X-Ray Technology Committee  
of the  
Association of Official Seed Analysts

by

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## RADIOGRAPHIC PLATES

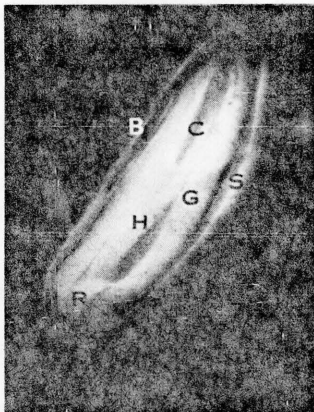
Genera are organized alphabetically, and are usually represented by a single species. If an uncommon trait or distinguishing characteristic is noteworthy for radiographic interpretation, additional species from the genus may be included. After the common name (in parenthesis), the image magnification is given. Each image is either longitudinal section (l.s.) or transverse section (t.s.). Longitudinal section is an image along the long axis and at a right angle to the transverse section, while t.s. is an image of the transverse section (also known as cross section) and at a right angle to the l.s.

The image sequence within the genus will be Normal, Empty, and Damaged with the damage identified. Image objects will be identified with the following letter designations:

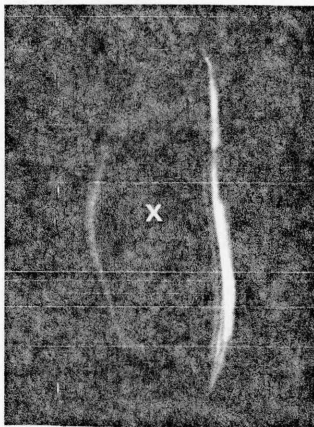
a coleoptile	i insect damage
z coleorhiza	l insect larva
c cotyledon	m mechanical damage
e embryo	p pericarp
n endosperm	k perisperm
x empty space or cavity	u plumule
f fruit	r radicle
g gametophyte tissue	t scutellum
w hilum	v seed
h hypocotyl	s seed coat

# ABIES

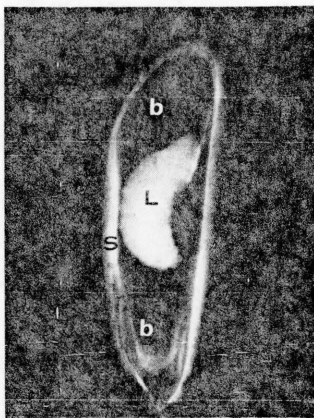
represented by *A. nobilis* (noble fir) x 4



Normal (l.s.)--a soft, rather thin seed coat surrounds gametophyte (endosperm) tissue with an elongated embryo in the center. The seed coat contains resin vesicles (b). The number, character and placement of the vesicles vary with species. Damage to these vesicles results in death of the seed. Seed may die in storage without changing radio-graphic image.



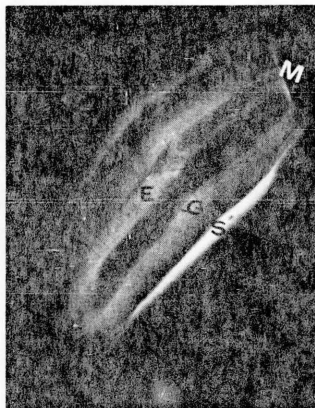
Empty (l.s.)--seed coat is void of any embryo material or food tissue. This seed is non germinable and often serves as a source of fungal contamination in germination tests.



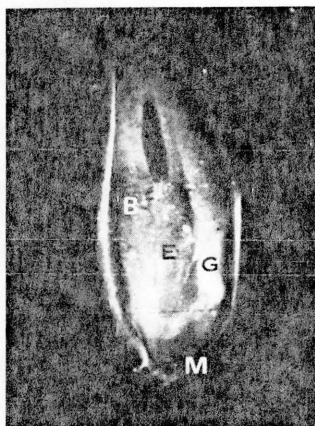
Damage--insect infestation (l.s.)--seed chalcid (*Megastigmus spp*) are common in *Abies*. These seeds are nonviable and usually a source of fungal contamination in tests.

## ABIES (cont.)

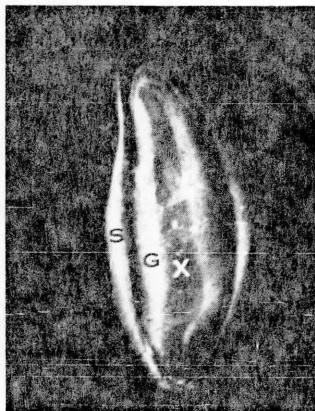
Damage--mechanical (l.s.)--the tip of the seed is broken off. This seed will usually produce normal germination immediately following processing. It will produce an abnormal germinant after a short storage period and will usually deteriorate in long term storage.



Damage--deterioration (l.s.)--The gametophyte tissue has begun to deteriorate (b) possibly due to mechanical damage on radicle end. Deterioration could also be caused by aging, heat or chemical toxicity. Seed will not usually germinate or if it does, it will be abnormal. A source of heavy fungal contamination in tests.

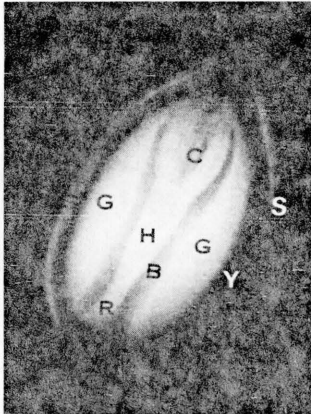


Damage--embryo less (l.s.)--embryo cavity has little to no embryo tissue. Seed is nonviable.

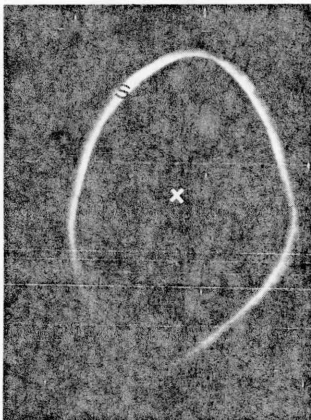


# PINUS

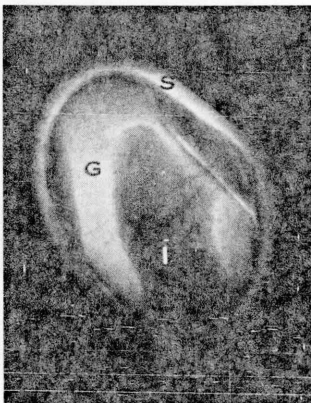
represented by *P. elliotii* (slash pine) x 5.5



Normal (l.s.)--a straight embryo is surrounded by gametophyte (endosperm) tissue. This in turn is surrounded by an inner (y) and an outer seed coat. Space between endosperm and seed coat is artifact of seed curvature. Space not filled in embryo cavity (b) is real. Cotyledons visible on upper end of embryo.



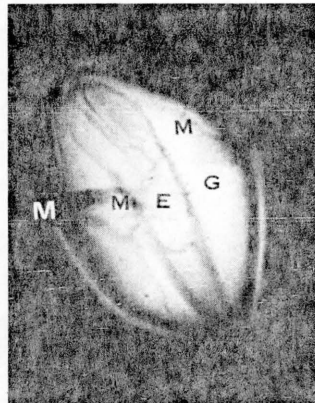
Empty (l.s.)--seed coat is nearly void of seed tissue.



Damage--insect (l.s.)--an insect larvae ate the embryo and some of the food tissue before exiting at the right. Cracks can be seen in the dried food tissue. The exit hole is to the right at the beginning of the cracks. Nonviable seed.

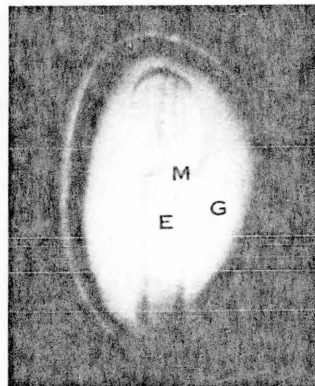
PINUS (cont.)

Damage--mechanical (l.s.)--the seed coat has been ruptured and the embryo broken. Seed is nonviable.

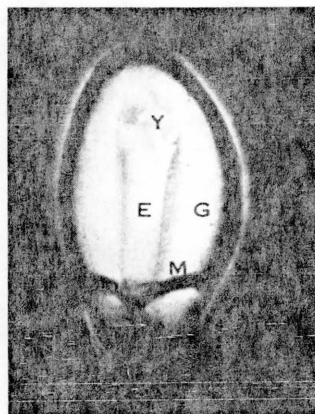


exceptions represented by *P. ponderosa* (ponderosa pine) x 7

Damage--mechanical (l.s.)--only damage is the break in the embryo at the junction of the cotyledons and the hypocotyl. No visible external damage found on this seed. Nonviable seed.



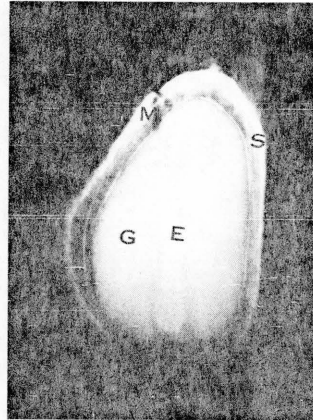
Damage--deterioration (l.s.)--the food tissue (endosperm) is shriveling with loss of detail. The cotyledons are deteriorating (y) and the endosperm has fractured on the basal end. Nonviable seed.



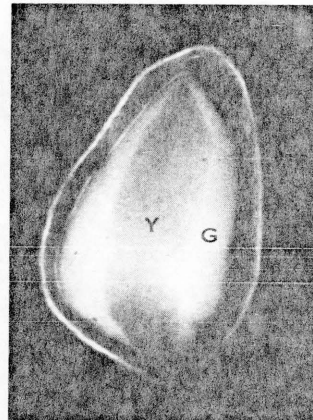


PINUS (cont.)

Damage--mechanical (l.s.)--the seed coat was ruptured. The food tissue and embryo absorbed moisture leading to deterioration. This species is very sensitive to deterioration particularly with increases in moisture content. Nonviable.

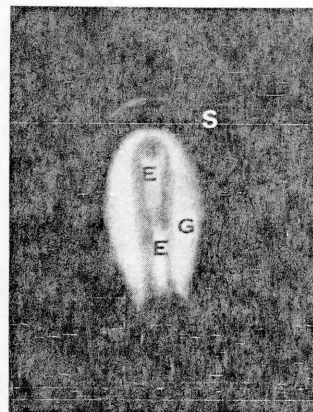


Damage--embryoless (l.s.)--the embryo cavity (y) is void of embryo material and the gametophyte tissue has shriveled from the seed coat.



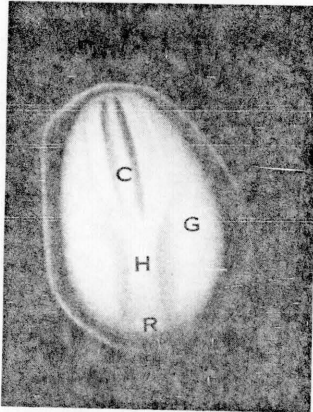
exceptions represented by *P. sylvestris* (Scotch pine) x 6

Normal (l.s.)--seed coat is so thin that it does not show up well on a radiograph. This seed possesses two embryos. Normally, only one will develop in a germination test.

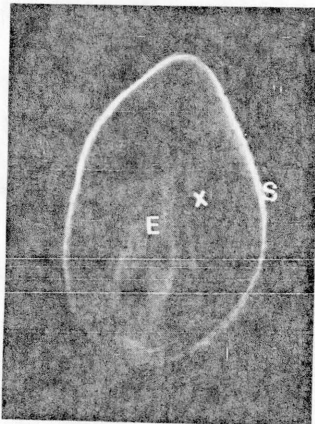


PINUS (cont.)

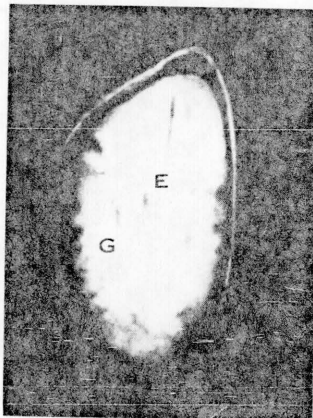
exceptions represented by *P. palustris* (longleaf pine) x 5



Normal (l.s.)--this species has a very thin seed coat and long cotyledons on the embryo. Because of the shape, more empty space is observed between the endosperm and seed coat.



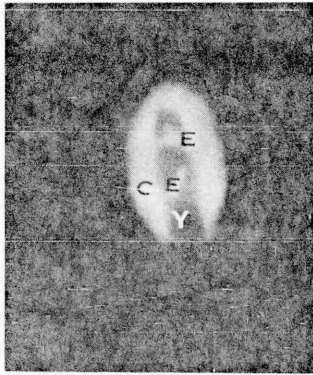
Empty (l.s.)--seed coat void of seed material. Inner seed coat is shriveled providing a ghost like appearance.



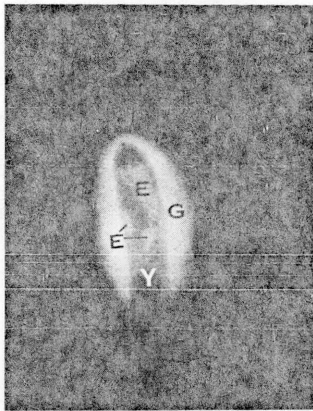
Damage--fungal (l.s.)--several fungal organisms are known to invade weak seed and mummify the contents. The image differs from deterioration by the appearance of solid material with a rippled or mottled image. Nonviable seed.



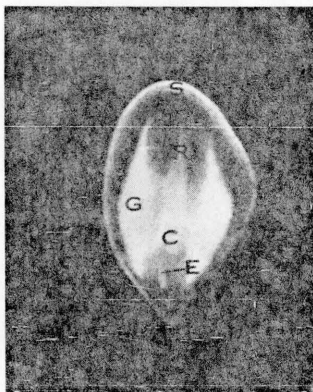
PINUS (cont.)



Abnormal (l.s.)--embryo cavity (y) contains two very small embryos. A small percent of this category will produce an acceptable seedling.



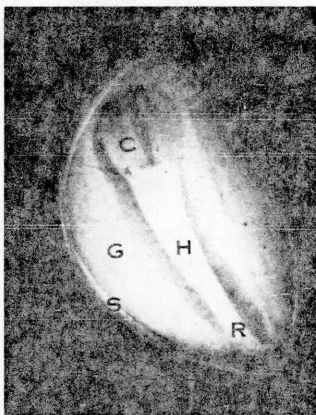
Abnormal (l.s.)--embryo cavity contains three embryos. Two are minute and one is half the length of the cavity. The larger will usually produce a seedling if it is at least half the cavity length.



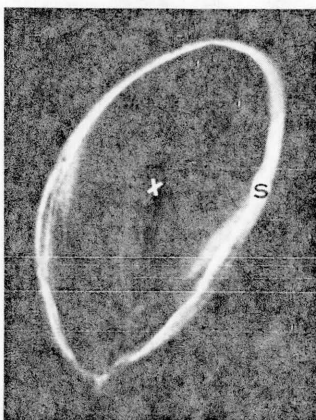
Abnormal (l.s.)--the embryo is inverted in the embryo cavity which is rare. A minute second embryo lies above the cotyledons of the first. Will often develop an abnormal seedling.

PSEUDOTSUGA

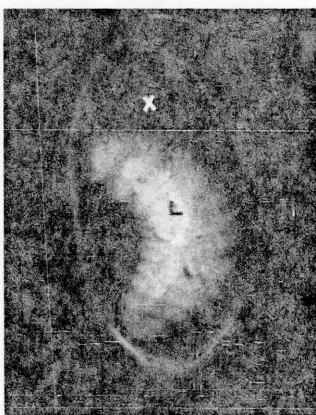
represented by *P. menziesii* (Douglas fir) x 9.5



Normal (l.s.)--this seed is like that of pine with an elongated embryo surrounded by gametophyte tissue (endosperm) which is enclosed in a hard seed coat.



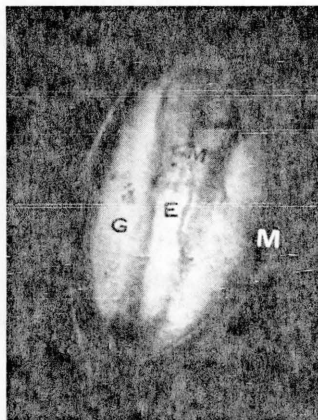
Empty (l.s.)--the seed coat is void of seed tissue.



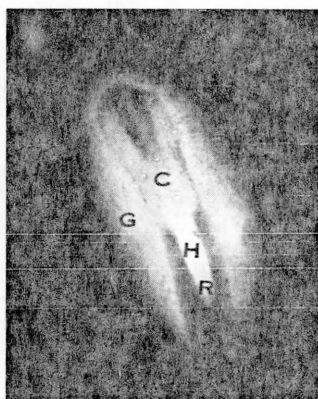
Damage--insect infestation (l.s.)--the seed coat is filled by a *Megastigmus* sp. larvae which has completely eaten the seed tissue.

PSEUDOTSUGA (cont.)

Damage--mechanical (l.s.)--seed crushed during extraction. Embryo fractured at hypocotyl and cotyledons. Seed nonviable.



Damage--developmental (l.s.)--extremely long cotyledons and narrow hypocotyl and radicle. This category will usually germinate, but will not always produce a seedling. Most often considered abnormal.



Damage--embryoless (l.s.)--embryo cavity empty. This is usually caused by genetic problems or by insects. Seed nonviable.

